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Black Carbon loss and structural modifications of different pyrogenic materials by microbiology activities

A. Hilscher (1), C. Siewert (2), H. Knicker (1)

(1) Lehrstuhl für Bodenkunde, TU München, 85350 Freising-Weihenstephan, Germany, (2)
Institut für Landschaftsarchitektur, Forschungsanstalt für Gartenbau Weihenstephan, 85350
Freising-Weihenstephan, Germany (hilscher@wzw.tum.de / Phone: +49-(0)8161-714186)

The residues remaining after incomplete combustion of vegetation (char) can contribute significantly to the carbon content of soils and sediments. To be able to estimate the resilience of such pyrogenic materials in soils, knowledge is required concerning their degradation rates and the respective humification mechanisms. In this study the pyrogenic organic materials (PyOM) was produced from rye grass (*Lolium perenne*) and pine wood (*Pinus sylvestris*) at 350°C under oxic conditions for one and four minutes to obtain residues with a different charring degree. The chars were mixed with a soil matrix of a B horizon of a Cambisol and incubated for 48 d at 30 °C under aerobic conditions. To simulate the input of fresh litter, entering the soil system after the death of fire-affected trees and vegetation, unburnt and finely ground rye grass was added as a co-substrate to one of the two replicates of each series after 1 and 3 weeks of incubation. The grass-derived PyOM showed the highest C mineralisation. During the 48 days of the incubation up to 3.2% of the OC was converted into CO₂. More severe thermal alteration resulted in a decrease of the total C volatilization from approximately 22% to 2.5% of OC. Only 0.66% and 0.46% of the initial C in the pine-derived PyOM were mineralised. The co-substrate additions resulted in no major enhancement of the PyOM mineralisation in this initial degradation step. The ¹³C NMR spectroscopic analysis of the chars indicates a modification of the chemical composition of the PyOM during the incubation. The grass PyOM lost alkyl C of up to 5.6% of its C. Concomitantly carboxyl/carbonyl C contents increased supporting that oxidation occurred, but only the strong thermally altered pine PyOM showed a

total reduction of the aromaticity of 3.5%. Since the total C loss during the experiment comprised only 0.46%, this indicates that some of the aryl C must have been converted into other C groups. As revealed by the increase of carboxyl/carbonyl C by 5.7% of the bulk char C, this conversion must include the opening and partial oxidation of aromatic ring structures. Our study demonstrates that pyrogenic materials, as it is produced by grassland fires or accumulated after incomplete combustion of litter during forest fires, can be microbiologically attacked and mineralised at rates that are comparable to SOM. Thus, such pyrogenic sources may not be as recalcitrant as commonly assumed and their role as a highly refractory constituent within the SOM may need revaluation.